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(54) Apparatus for a paper/board machine and use of the same.

(57) An apparatus for a paper or board machine, said apparatus including a pressure-tight chamber. The chamber is adapted cross-directionally to the travel of a wire, felt or similar fabric so as to essentially extend over said fabric. The invention is characterized by having the pressure-tight chamber adapted to include a roll (1) with an at least partially permeable shell. The roll shell surface is advantageously formed by a fabric, furthermore, the roll is appropriately free-rotating mounted in bearings at both ends of roll shaft. The invention is further characterized by having the pressure-tight chamber operated with an over- or underpressure relative to the ambient pressure about the chamber.

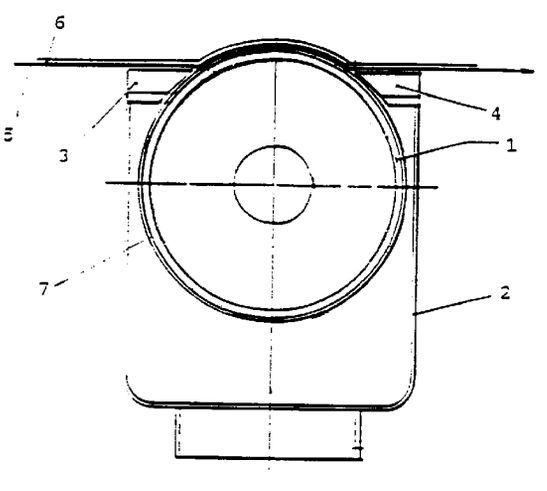

Fig. 1

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The present invention relates to an apparatus in accordance with the preamble of claim 1 for use in a paper/board machine.

Conventionally, water removal in the wire section has taken place by means of gravity, table rolls, hydrofoils, vacuum foil boxes, flat suction boxes, centrifugal force and moving vacuum rubber belts. As a rule, all paper/board machines employ a combination of the above-mentioned water removal methods.

The functions of the wire section have been characterized by the concomitant increase of the wire section frictional load with the increase of the machine speed as higher vacuum is required due to the need for keeping the solids at a constant level. However, this results in running problems and intermittent stops of the wire section. A major portion of the frictional wire load occurs in the region of the wet suction box, where the wire is sucked against the suction box surface with a high force that is exerted over a large area.

The flat suction box has a limited water removal capability. Its effect can be increased by using a higher vacuum, whereby also the friction between the box cover surface and the wire increases, which results in greater wire wear and shorter life. The friction sets the limit to the maximum usable vacuum in the box. If the vacuum is above a certain limit, the wire stops from moving. In paper machines arming the sheet from pulp containing carbonate filler, the elevated friction causes rapid wire wear.

Moving vacuum belts made from rubber (e.g., Rotabelt, FLO-VAC) are capable of eliminating the friction caused by the vacuum, but the high vacuum employed results in sheet marking by the slot pattern of the belt. Rubber belts are extremely costly and difficult to service. Moreover, they are problematic to drive.

Felt suction box is a typical felt conditioner. Its operation requires a vacuum of 5-6 mH_2O, which must be accomplished using suction pumps. The felt suction box causes rather heavy felt wear on the side supporting the web and results in unnecessarily premature felt changes. The amount of air flow through the suction box is crucial to the conditioning result. In new felts the air is freely sucked through the felt, but with the gradual plugging of the felt, the amount of air passing through the felt is reduced. Then, the water removal capability of the felt conditioner is impaired as the amount of air sucked through the felt is no longer sufficient to remove all water from the felt.

To overcome the above-described problems, a novel water-removal method has been developed capable of minimizing the frictional effect of suction and providing sufficient working time for the suction. The characterizing properties of the apparatus according to the invention for use in a paper/board machine are disclosed in the appended claims.

In the embodiment according to the invention, a permeable jacket roll, most advantageously a fabric-jacketed roll, is adapted in a pressure-tight chamber, advantageously a suction box. The fabric-jacketed roll supports the running wire during the suction and provides a working time for the suction acting on the sheet between the box sealing strips that is several times longer and uninterrupted with regard to a perforated suction box. The rotary suction box with the fabric-jacketed roll becomes the more effective the larger the fabric roll diameter, that is, the working time of the suction. However, the suction capacity must be herein increased appropriately. The benefit of the fabric roll over a conventional suction roll is its freedom from causing web marking, which facilitates the use of the present arrangement with extremely fine grades of paper and board. The apparatus according to the invention, which advantageously is a rotary fabric-roll suction box, said apparatus incorporating a pressure-tight chamber such as a vacuum or a pressure box, and in conjunction with said pressure-tight chamber is adapted a permeable jacket roll, advantageously a fabric-jacketed roll, is superior over the prior art with the benefits described below. A flatbox, or a suction box, wastes a portion of the vacuum energy as friction which at its worst hampers the driving of the wire (making the wire slip). The rotary fabric-roll suction box according to the invention resists the running of the wire only by the amount of the friction occurring in its bearings. The friction of a suction box causes the wire to wear from its underside. This effect may cause problems particularly in paper machines using filler-containing stock. Obviously, wear is faster, the higher the vacuum in the box. By contrast, no sliding friction occurs between the rotary fabric-roll suction box and the wire, consequently causing no wire wear due to friction.

Conventionally, a suction box is operated at the maximum vacuum still permitting the running of the wire and not yet causing excessive economical problems from wire wear. By contrast, a rotary fabric-roll suction box can be operated with a vacuum determined by the local situation or need. The limit of high vacuum is dictated by the structural strength of the roll. A moderate vacuum can be used in the rotary fabric-roll suction box still achieving good suction result (owing to the long working time of the vacuum), and the content of fine solids in the sheet can be kept higher than with the use of a suction box. The vacuum reserve of a suction box is available at the distance of the ceramic box cover from the sheet. By contrast, the rotary fabric-roll suction box puts the vacuum reserve at the sheet surface by virtue of the open structure of the roll and the wire. Consequently, the efficiency of the suction provided by the fabric roll is better than that of the suction box.

The suction working time provided by the rotary fabric-roll suction box is several times (depending on the fabric roll diameter and box geometry) that achievable by the use of a suction box. In a suction box the vacuum

is cut off after each hole of the perforation. In other words, a portion of the vacuum energy is used at each hole for restarting the suction work. By contrast, in a rotary fabric-roll suction box the vacuum prevails over the entire machine-directional width of the suction box opening, whereby energy is lost only once for starting the suction work.

The unit price of the rotary fabric-roll suction box is in the same order with suction boxes it replaces. The vacuum arrangement is simpler than that of a suction box, requiring less expenditure in the erection of new installations. Due to the lower energy losses of the rotary fabric-roll suction box, the operating costs are reduced.

A suction roll of the paper machine can normally be operated with the maximum vacuum permitted the sheet quality and physical laws (temperature). Analogously to the suction roll, the usable maximum vacuum in the rotary fabric-roll suction box is limited by the roll construction or sheet temperature.

Due to the permeable structure of the roll surface, the rotary fabric-roll suction box system is free from the sheet marking tendency. By contrast, the proportion of suction holes drilled on a suction roll shell is normally only approx. 50 % of the suction roll surface, whereby the drilling pattern of the suction roll easily marks the sheet if the solids content of the sheet is too low when reaching the suction roll.

The rotary fabric-roll suction box system achieves a significantly longer vacuum zone along the machine-directional travel of the sheet as the vacuum prevails in the box enclosing the fabric roll. On a suction roll, the vacuum zone length is limited by the arc covered by suction box adapted to the inside of the suction roll. In practice, the vacuum zone of a suction roll in the machine direction covers approx. 100 mm, while in a rotary fabric-roll system the vacuum zone can have a length in excess of 200 mm.

In a suction roll the vacuum reserve is displaced at a distance (approx. 70-80 mm) of the roll shell thickness from the point of suction. In a rotary fabric-roll system the vacuum reserve is located immediately under the wire. This is because all flow-choking constrictions are eliminated from the system.

A suction roll is expensive due to special materials and manufacturing methods required. The fabric-jacketed roll has simpler construction and is accordingly cheaper to manufacture.

A suction roll is difficult to clean due to its closed structure. Owing to its opens structure, the fabric roll/suction box system is easy to clean.

All servicing points of a suction roll are located to the interior of the roll with the exception of the bearings, requiring the removal of the roll from the machine and dismantling thereof for scheduled maintenance. By contrast, all essential service-requiring component of the rotary fabric-roll system are located on the outer surface of the apparatus, where they can be serviced or replaced during a shut-down without the need for removal of the apparatus from the paper machine. The only exception is the fabric jacket of the roll (a wire jacket).

The fabric roll causes a small bump on the wire travel, but eliminates almost entirely the sliding friction. Hence, the only resistance to the wire travel is comprised by the friction of the support strips and the rotational friction of the bearings. The rotary fabric-roll suction box facilitates the use of demand-controlled pressure gradient for water removal at the outgoing end of the wire section, which in multi-ply sheet formation improves bonding between the plies, and in all sheet formation elevates the solids content. In terms of specific suction energy consumption, the rotary fabric-roll suction box provides higher economy than a set of suction boxes with a corresponding effective area of suction openings. The rotary fabric-roll suction box is capable of replacing 3-5 suction boxes of equal size. The cost of the rotary fabric-roll suction box is only a fraction of the cost of a suction roll and a moving slotted-rubber vacuum belt. It is quieter and can be operated with smaller pressure gradient due to its longer suction working time. Accordingly, the vacuum can be produced using a suction fan which needs less energy than a liquid-ring pump. Reduced wear also means less wire wear and extended wire life. Successful suction action with a reduced pressure gradient helps keeping the fine solids in the sheet, whereby the final product smooothness is improved. The rotary fabric-roll suction box system is easier to keep clean than a suction roll and a suction box as the mixture of suction air and drained water passes through the fabric roll from roll inside radially outward on the opposite side to that facing the wire thus removing particulate matter adhering to the roll surface.

The vacuum box into which the fabric roll is adapted must be rigid enough to support the vacuum without dimensional changes. Correspondingly, the fabric roll must take the forces imposed by the vacuum prevailing in the vacuum box without any bending or dimensional changes. If the roll shaft is designed to extend through the entire length of the roll, the free space formed between the shaft and the shell of the roll must be at least half the width of the suction opening in order to avoid choking of the suction flow in the suction working area due to obstructions in the roll construction.

The proportion of suction openings on the roll shell must be as high as possible to achieve as homogeneous vacuum at each point of the shell surface as possible.

The roll shell is jacketed by a shrinkable fabric with a mesh of four yarns per centimeter, for instance. Such a permeable fabric serves for optimally equalizing the vacuum over the entire area of the suction opening by

slightly displacing the running wire from the roll shell surface.

Further applications of the apparatus according to the invention for a paper/board machine can be found as, e.g., a felt conditioner, a pressure-gradient dryer on the press section and an application in a twin-wire machine. Herein, related to paper and board machines designed for running the sheet between two wires, a pressure box fed with heated compressed air is adapted at the rotary fabric-roll suction box. By virtue of the overpressure prevailing in the pressure box, the water contained in the sheet is expelled to the working range of the suction box vacuum. Using the rotary fabric-roll suction box according to the invention, a wire section can be constructed by taking the wires of a twin-wire section in a zig-zag fashion for water removal so that a first rotary fabric-roll suction box is adapted to blow, a second is adapted to suck from the opposite side, and a third is again adapted to blow from the same side as the first rotary fabric-roll suction box. Hence, the water removal always occurs in the same direction, whereby the best efficiency in water removal is achieved. Under the blowing fabric-roll boxes is adapted a vacuum box similar to the blowing boxes, whereby air passage through the wire is augmented enhancing the drying result. Herein, the vacuum level may not be adjusted so high that the vacuum-side wire is detached from the sheet.

The invention is further related to the use of the apparatus for a paper/board machine advantageously as a water removal unit, pressure-gradient dryer or felt conditioner.

The invention is next examined in greater detail with reference to exemplifying embodiments illustrated in the appended drawings, in which

Figure 1 is an end view of the apparatus according to the invention for a paper/board machine;

Figure 2 is a three-dimensional projectional view of the apparatus illustrated in Fig. 1;

Figure 3 is a diagrammatic layout view of an application of the apparatus according to the invention as a pressure-gradient dryer on the press section;

Figure 4 is a diagrammatic layout view of an application of the apparatus according to the invention on a twin-wire section; and

Figure 5 is a diagrammatic layout view of an application of the apparatus according to the invention as a felt conditioner.

With reference to Figs. 1 and 2, a permeable jacket roll 1, advantageously a fabric-jacketed roll, is adapted to the inside of a pressure-tight chamber 2, advantageously a vacuum box. The upper surface of the roll 1 remains over the top surface of the box 2. The pressure gradient, advantageously a vacuum, provided by the box is exerted via the roll 1 and the wire 5 to a sheet 6 running on the wire. As the sheet 6 rests on the wire 5, the vacuum sucks the wire 5 against the fabric surface of the roll 7, whereby the roll 1 starts to rotate at the speed of the wire 5. During the rotation of the roll 1, the sheet 6 running on the wire 5 is subjected to suction which prevails with a constant pressure gradient all the way from the incoming side sealing strip 3 to the outgoing side sealing strip 4 of the box 2. The long working time of the suction makes the water removal action highly efficient, and the fabric jacket 7 equalizes the suction in a marking-free manner over the entire area of the suction opening.

With reference to Figs. 3 and 4, such applications of the apparatus according to the invention are shown in which the pressure-tight chamber 2 is used as a pressure box. The pressure box is advantageous in situations needing detachment of the sheet 6 from the wire 5, or alternatively, water removal from the sheet 6 in a direction opposite to the box. Normally, such an application using the pressure box presumes a twin-wire section. Then, the pressure box may be opposed by a vacuum box, whereby the vacuum may not, however, be adjusted so high as to detach the vacuum-side wire from the sheet.

With reference to Fig. 5, an application of the apparatus according to the invention for use as a felt conditioner is shown. Herein, the pressure-tight chamber 2 included in the apparatus is used as a pressure box. Replacing the felt guide roll, the apparatus is advantageously placed at a location where the felt is maximally deflected. To the other side of the felt is adapted a vacuum box for drainage of the water removed from the felt. So much heated air is passed to the pressure box 2 including the roll 1 that a continuous overpressure is established inside the roll 1. The overpressure expels water contained in the felt, which action is further augmented by the centrifugal force generated by the felt travel about the perimeter of the rotating roll 1. The vacuum trough placed on the opposite side of the felt is connected to a suction fan suited to produce a moderate vacuum to said opposite side of the felt.

The apparatus described herein is also well suited for use as a conditioner for a wet wire and a drying wire.

When equipped with a pressure box, the apparatus according to the invention is an excellent replacement for a wire guide shoe. Complementing the centrifugal action, the pressure gradient provided by the apparatus enhances water removal. Moreover, the wearing action imposed by the guide shoe on the wire is eliminated resulting in longer wire life.

To one skilled in the art it is obvious that the invention is not limited by the exemplifying embodiments

described above, but rather, can be varied within the scope and spirit of the annexed claims.

Claims

1. An apparatus for a paper or board machine, said apparatus including a pressure-tight chamber (2) and said chamber being adapted cross-directionally to the travel of a wire, felt or similar fabric (5) so as to essentially extend over said fabric (5), **characterized** in that to the pressure-tight chamber (2) is adapted a roll (1) having an at least partially permeable shell.

2. An apparatus as defined in claim 1, **characterized** in that to said pressure-tight chamber (2) is adapted at least one sealing strip (3, 4), nozzle or similar element and a roll (1) with an essentially permeable shell, said roll (1) being mounted preferably free-rotating in bearings adapted to the ends of the roll shaft (12).

3. An apparatus as defined in any foregoing claim, **characterized** in that said roll (1) comprises an essentially cylindrical and permeable shell, a shaft (12) and at least one support element joining the shell to the shaft such as a support plate (8), support strip (9) or support wire (10).

4. An apparatus as defined in any foregoing claim, **characterized** in that the total area of openings on the shell of the roll (1) is at least 50 %, advantageously 60 - 80 %, of the shell total area.

5. An apparatus as defined in any foregoing claim, **characterized** in that the shell of the roll (1) is advantageously formed by a fabric jacket.

6. An apparatus as defined in any foregoing claim, **characterized** in that the shell of the roll (1) is coated with a jacket such as a shrinkable wire or similar material (11).

7. An apparatus as defined in any foregoing claim, **characterized** in that the free space formed between the shaft and the shell of the roll is at least 50 %, advantageously 60 - 80 %, of the width of the suction opening.

8. An apparatus as defined in any foregoing claim, **characterized** in that said roll (1) is adapted in conjunction with at least one pressure-tight chamber (2).

9. An apparatus as defined in any foregoing claim, **characterized** in that said pressure-tight chamber (2) is operated with an over- or underpressure relative to the ambient pressure said chamber.

10. An apparatus as defined in any foregoing claim, **characterized** in that said pressure-tight chamber (2) is operated with an overpressure in the range of 0 - 0.25 bar, or correspondingly, with an underpressure in the range of 0 - 0.5 bar.

11. An apparatus as defined in any foregoing claim, **characterized** in that the overpressure or underpressure, respectively, prevailing in said pressure-tight chamber (2) acts radially essentially through the entire roll (1).

12. Use of a roll (1) in a paper/board machine, said roll having an at least partially permeable jacket and said roll being adapted to a pressure-tight chamber (2).

13. Use as defined in claim 12 advantageously as a water removal unit, pressure-gradient dryer or felt conditioner.

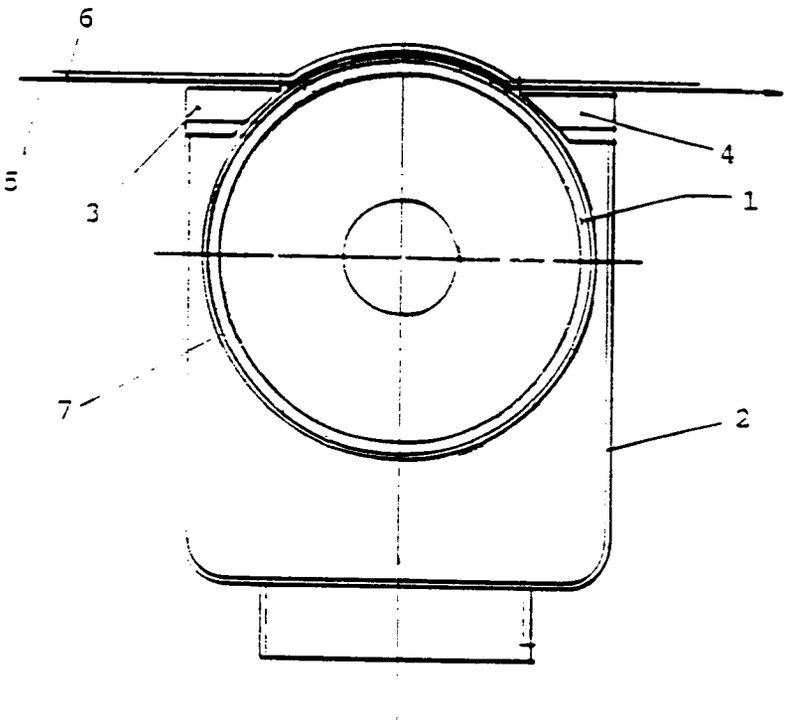

Fig. 1

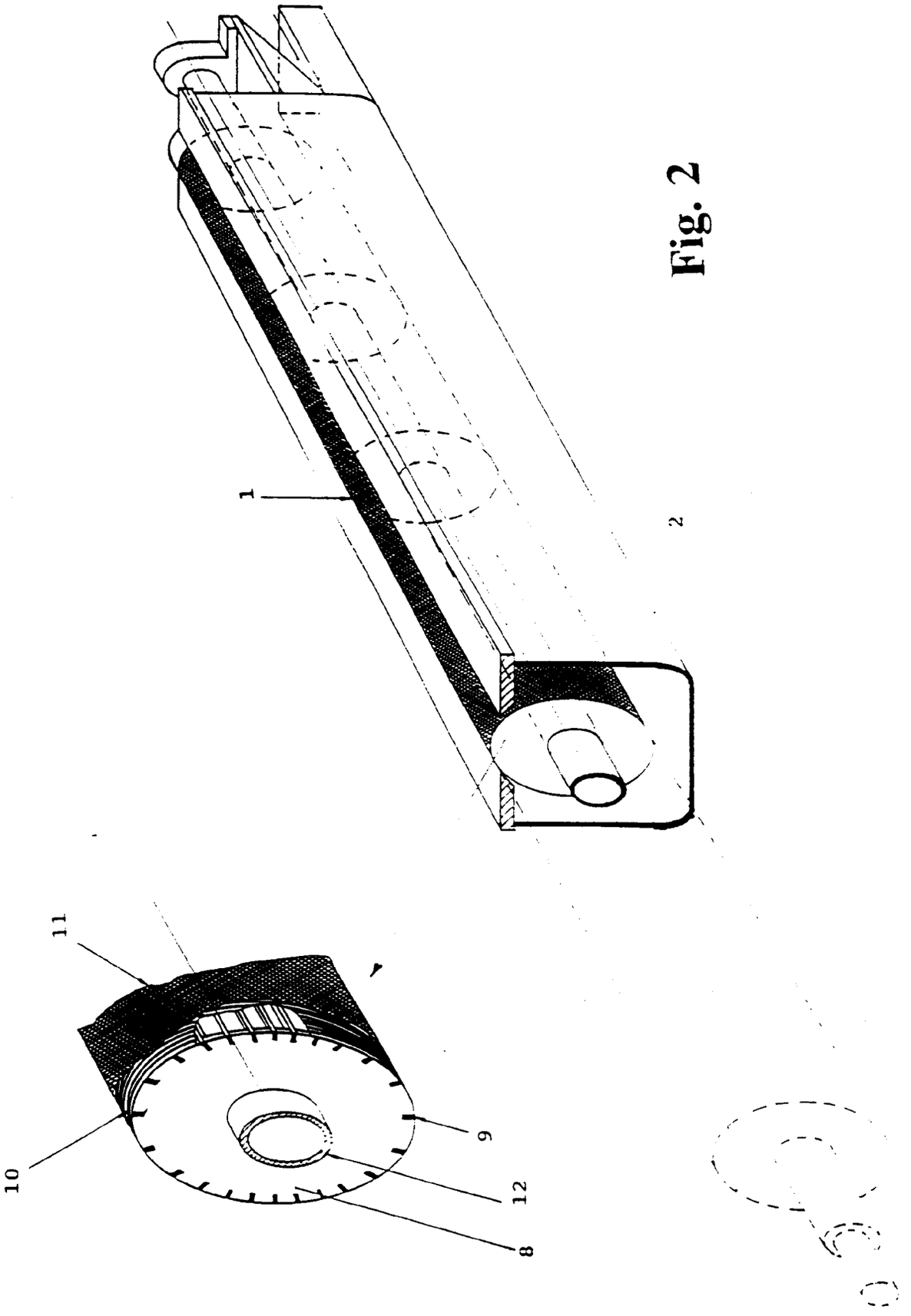

Fig. 2

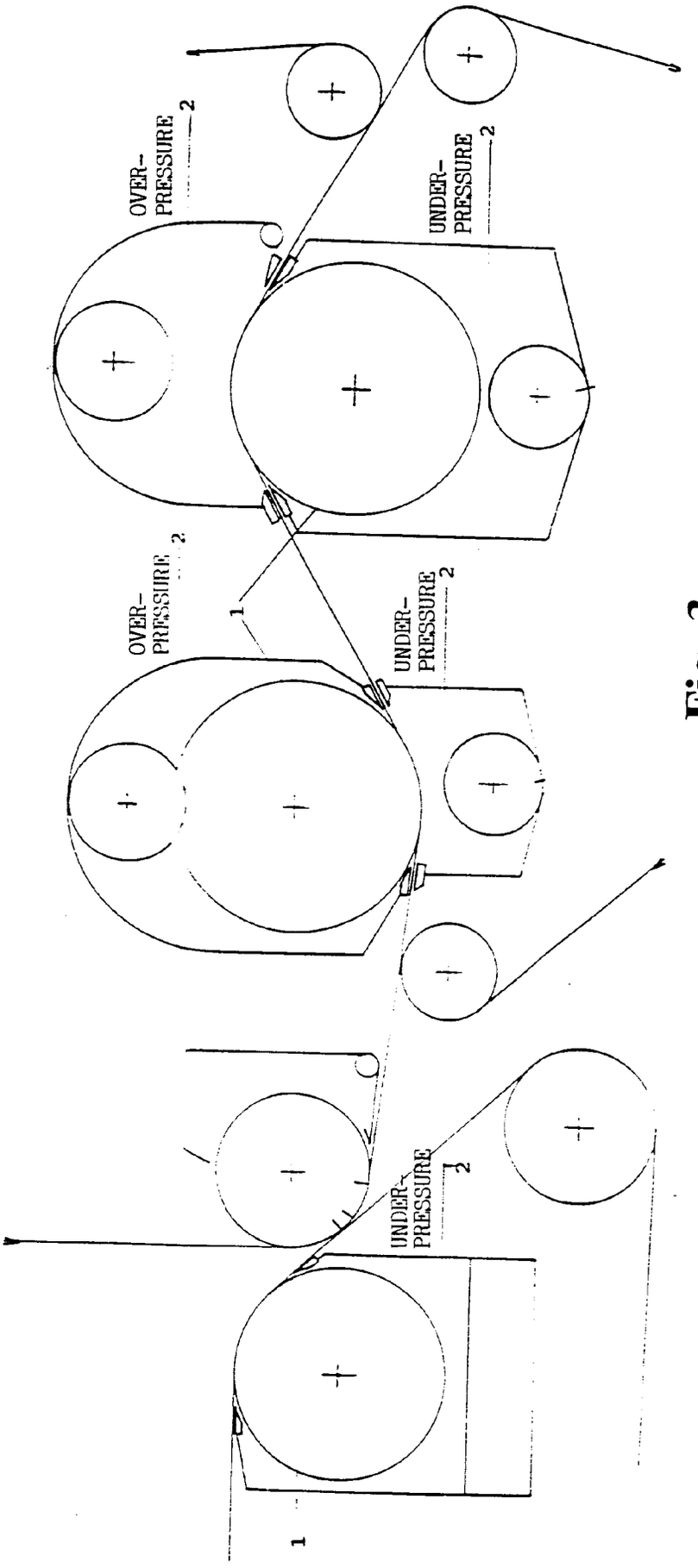
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Fig. 3

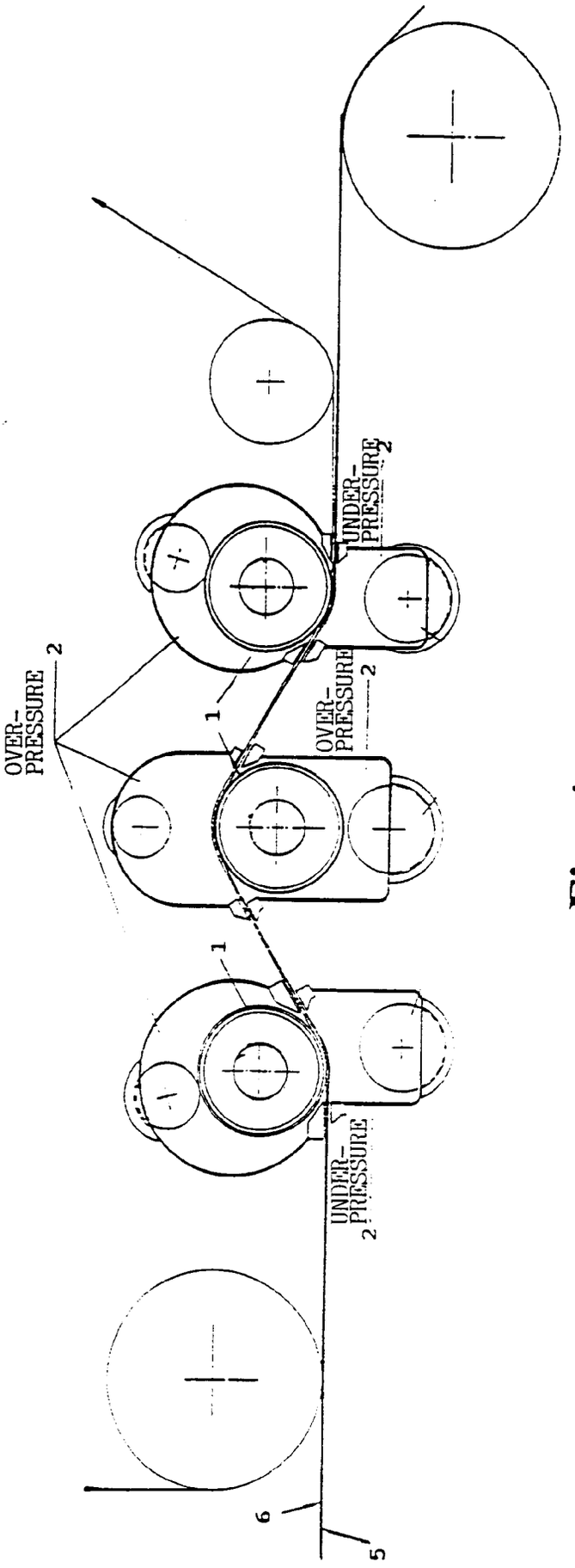
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Fig. 4

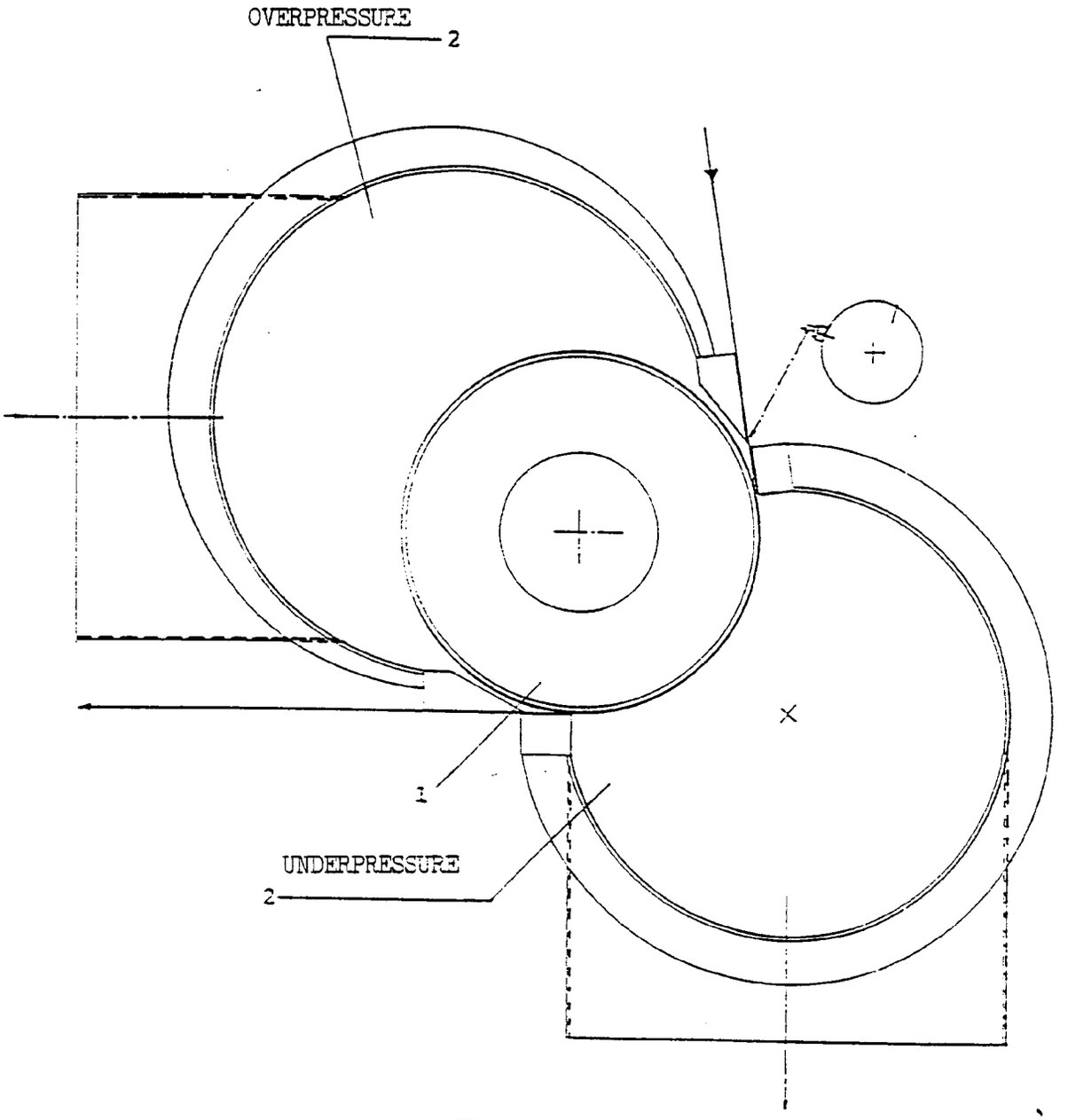

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 94 85 0139

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-2 270 464 (W. C. NASH) * the whole document * ---	1-9, 11-13	D21F1/50
X	FR-A-2 364 291 (VALMET OY) * page 10, line 8 - page 11, line 28; figures 2,3,8 * -----	1-3,7-9, 11-13	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

D21F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 December 1994	DE RIJCK, F

CATEGORY OF CITED DOCUMENTS

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